# **Introduction to Natural Hazards**

#### **Chapter 1**

# **Framework for Each Chapter**

## Learn the Objectives of the Chapter

## Introduction to each hazard

## Examine the processes of the hazard

## The cycle of the hazard

## Geographic regions at risk of this hazard

## Natural functions of the hazard

## Human interaction with the hazard

## Minimizing the risk of the hazard

## Looking at the Perception of and Adjustments to the risks of the hazard

# **Learning Objectives**

## Learn the difference between a disaster and a catastrophe

## Learn the components and processes of the geologic cycle

## Understand the scientific method

## Understand the basics of risk assessment

## Recognize natural hazards that cause disasters are generally high energy events caused by natural earth processes

## Understand the concept that the magnitude of a hazardous event is inversely related to its frequency

## Understand how natural hazards my be linked to one another and to the physical environment

## Recognize that increasing human population and poor land-use practices compound the effects of natural disasters and catastrophes

# **Why Study Natural Hazards?**

## To learn about the internal and external forces of the earth and how they interact with civilization

## To learn how civilization can better adjust and adapt to these forces

## To learn to appreciate and respect the awe of these processes and their effects

# **Processes: Internal and External**

## **Process – the physical, chemical, and biological ways by which events effect the earth’s surface.**

### **Internal**

#### **Tectonic**

##### Volcanic eruptions

##### Earthquakes

### **External**

#### **Climate and Weather** – Part of the Hydrological Cycle

##### Hurricanes and Tornados

#### **Mass Wasting of the Earth’s Surface**

##### Landslides

##### Flooding

# **Hazard, Disaster, or Catastrophe**

## **Natural Hazards**

### A natural Process and/or Event that is a potential threat to human life and property

#### The Event is not the problem, but the danger to humans and their property determines if the Event is to be a Hazard.

#### Affects millions of people around the world

##### Blizzards and Ice Storms

##### Wildfires

##### Tsunamis

##### Droughts

##### Subsidence

##### Coastal erosions

##### Impacts from asteroids and comets

# **Disasters**

## **What is A Disaster?**

### A Hazardous Event that occurs over a limited time span in a defined area

#### Criteria:

##### Ten or more people killed

##### 100 or more people affected

##### A state of emergency is declared

##### International assistance is requested

### During past few decades, natural disasters have killed several million people, average loss of life about 80,000 people.

### Financial loss – exceeds $50 Billion a year.

# **Catastrophes**

## **What is a Catastrophe**

### A massive disaster that requires significant expenditure of money and a long time recovery to take place

#### Some of the most current Catastrophes are:

##### Hurricane Katrina - 2005

##### Haiti Earthquake - 2011

##### Indonesia Earthquake and Tsunami -2004

##### Bangladesh Hurricane - 1991

##### Japan Earthquake and Tsunami- 2011

##### The Northeaster and Hurricane Sandy Combination - 2012

# **Deaths and Damage Caused by Natural Hazards**

## To compare the effects of various natural hazards, we look at the greatest loss of life.

## Next we look at the property damage

### How much was the cost

### How many people does this damage effect

### The most important to look at is the potential to produce a catastrophe.

# **Which Hazards Could Cause Catastrophes**

### **High risk hazards**

#### Floods

#### Hurricanes

#### Tornadoes

#### Earthquakes

#### Volcanic Eruptions

#### Large Wildfires

#### Heat Waves

### **Moderate and low risk hazards**

#### Landslides (effects a smaller area)

#### Drought

#### Coastal Erosion

#### Frost

#### Lightening

#### Expansive Soils

#### Extra Terrestrial impact

# **Understanding Hazards through History**

## Natural Hazards are repetitive through history

## By studying the history of natural hazard events, we can gain information for a hazard-reduction plan.

### Some of these plans are

#### Better building requirements (for earthquakes and floods)

#### Where are natural flood plains

#### Understand the land for potential landslides

## To totally understand Nature and all its hazards, we must study and understand information to gain a background of the natural processes of the earth

# **Geologic Time**

## Earth is about 4.6 billion years old

## Age of the dinosaurs 160 million years ago

## Rocky Mountains uplifted 65 million years ago

# **Geologic Cycle**

## The Geologic conditions and materials largely govern the type, location, and intensity of natural processes.

## An understanding of the components and dynamics of the geologic cycle will explain these relationships

# **Geologic Cycle**

## **What describes the Geologic Cycle**

### Throughout the 4.6 billion years of the Earth’s history materials on or near the earth’s surface have been created, maintained, and destroyed by numerous physical, chemical, and biological processes.

### These processes produce earth materials, land, water, and atmosphere, necessary for our survival.

### These processes are called the **geologic cycle** made up of

#### **The Tectonic Cycle**

#### **The Rock Cycle**

#### **The Hydrology Cycle**

#### **The Biogeochemical Cycle**

# **Tectonic Cycle**

## ***Tectonic***refers to the large-scale geologic processes that form and deform the Earth’s crust and produce landforms such as ocean basins, and continents, and mountains

## The **Tectonic cycle** involves the creation, movement, and destruction of these tectonic plates.

## It is responsible for the production and distribution of rock and mineral resources invaluable to modern civilization, as well as hazards such as volcanoes and earthquakes.

# **Rock Cycle**

## Rock Cycle

### Rocks are aggregates of one or more ***minerals***.

### It is the largest geologic sub-cycle and it is linked to all the other sub-cycles

#### Depends on:

##### The tectonic cycle for heat and energy

##### The biogeochemical cycle for materials

##### The hydrologic cycle for water

# **Hydrologic Cycle**

## Hydrologic Cycle

### Water Vapor in the air returns to the earth through precipitation

### Moves through the earth in streams, ground water and evaporation or evapotranspiration

### Returns to the oceans and the air to start again

# **Biogeochemical Cycles**

## The transfer or cycling of a **chemical element or elements** through the atmosphere, lithosphere, hydrosphere, and biosphere

## The **tectonic cycle** provides water from volcanic processes as well as heat and energy used to for and change the earth materials

## The **rock and hydrologic cycles** are involved in many processes that transfer and store chemical in water, soil and rock.

## **Biogeochemical cycles** can most easily be described as the **transfer of chemical elements through a series of storage compartments or reservoirs**

#### Air, Soil, Groundwater and Vegetation

# **Fundamental Concepts for Understanding Natural Processes as Hazards**

## **Five Basic Concepts to Understanding Natural Hazards**

### Hazards are **predictable from scientific evaluation**

### **Risk analysis is an important component** in understanding the effects of hazardous processes

### **Linkages exists between different natural hazards** as well as between hazards and the physical environment

### **Hazardous events that previously produced disasters are now producing catastrophes**

### **Consequences of hazards can be minimized**

# **Concept: 1**

# **Hazards are Predictable from Scientific Evaluation**

## Science and Natural Hazards

### Use of the Scientific Method

#### Formulate a question

#### Develop a hypothesis

#### Test the hypothesis with experiments

### From the results of the experiments, develop a conclusion

## Use Scientific Method to understand and develop a predict natural hazards

### **Hazards are Natural Processes**

#### Modern humans seem to be a product of the Pleistocene ice age of 1.8 million years ago

##### There has been rapid climate change from harsh glacial conditions to a few thousand years ago when the climate began to warm.

##### We had to learn to “adapt and overcome” these climate chances in order to survive.

#### Events we call **Natural Hazards** are **Natural** **Earth processes**

#### These **natural processes** only become **hazards** when they happen **where people are**

#### They become **hazards** when we humans change the land-use by urbanization or by deforestation.

#### We, as humans, should realize these hazards, and try **minimize these processes**

# **Forecast, Prediction, and Warning**

## **Predicting Changes in the Earth System**

### **Uniformitarianism:** “*the present is the key to the past.”*

#### The fundamental concept of earth sciences is as the earth processes wear down the earth’s surface, the earth processes builds the surface back up

#### Human activities can effect these changes

## Now we have to look at:

### **Environmental Unity**- “*the present is the key to the future.”*

#### One action causes others in a chain of actions and events

#### “Removal of vegetation on a steep hillsides can bring on landslides in a rain storm”

## **Prediction** involves specifying the **date**, **time**, and **size** of a hazardous event

### Different from predicting where or how often a particular event will occur

## A **forecast** has a **range of certainty**. This involves a percentage of certainty that an event will happen.

### By giving a **forecast** of an event, the loss of life can be minimized and there will be less property damage

## **Study of natural hazards** helps in the improvement in **forecasting** when the events will happen

## By knowing the **probability and the possible consequences** of an event, we can assess the risk of that event and give **warnings**

## **Minimizing the effects of a hazardous event by:**

### **Identifying the location** where a hazardous event is likely to occur

#### Mapping the kind of hazardous events and where they might happen around the world

### **Determining the probability** that an event of a given magnitude will occur

#### Determine the probability of a particular event in a particular location within a particular time span

### **Observing any precursor events**

#### Many hazardous events are preceded by*precursor events*

### **Forecasting or predicting** the event

#### When a forecast of an event is issued, the certainly is given in a percentage of an event happening

#### Using the four preceding methods, a prediction can be made that an event will happen

### **Warning** the public

#### Information of the possibility of a hazardous event happening

# **Concept: 2**

# **Risk Analysis: Understanding the Effects of Hazardous Processes**

## **Risk of a particular event**

### The product of the probability of that event occurring the times the consequences should it occur.

### **Consequences** may be expressed on a variety of scales

## Determining ***acceptable risk*** is complicated . This depends on the situation.

### Governments may require a person to get flood insurance if there is a high risk of flooding in the area that live

### Individuals can choose where they live if there is a possibility of flooding, earthquakes, hurricanes and even a volcano eruption

## Connections exist between Natural Hazards and Hazards and the Physical Environment

* **Concept: 3**

**Linkages**

* + **Connections exist between Natural Hazards and the Physical Environment**

## These are called **Linkages**

### Volcanic eruptions on land are linked to mudflows and floods

### Eruptions in the ocean are linked to tsunamis

## **Natural hazards are linked to earth materials**

### Exposures of shale to landsides

### Granite to large fractures of rock

* **Concept: 4**

**Hazards Events that Previously Produced Disasters are Now Producing Catastrophes**

## As the earth’s **population has increased, natural hazards that once caused disasters, now cause catastrophes**

## This **population was soon civilized, lived closer together and built large cities**. As this happens a **disasters becomes a catastrophes**

### Example: Mexico City built on an ancient lake bed, in September of 1985 experienced a magnitude 8.0 earthquake, killing 10,000 people.

### Example: Japan’s earthquake and tsunami in 2011. Magnitude 9.0, 10 meter high tsunami waves, 16,000 killed

## Increase in the population growth

### Between 1830 to 1930 – **100 years**, the world population increased from **1 to 2 billion**

### Between 1930 to 1970 – **40 years**, the world population increased to **4 billion**

### Between 1970 to 2000 – **30 years**, the world population increased to **6 billion**

### And from 2000 to July 1, 2013 – **12 ½ years**, the world population increased to **7.16 billion people**

## This is why, if a **natural hazard does occur, it will most likely will either be a disaster or a catastrophe**

## **Magnitude and Frequency of Hazardous Events**

### The ***impact*** of a hazardous event is in part a function of the amount of energy release, that is the **magnitude** and the interval between occurrences, its **frequency**

### The ***impact*** is also influenced by other factors including:

#### Climate

#### Geology

#### Vegetation

#### Population

#### Land-use

### Learning to look at these and other factors on natural hazards may **lessen these impacts** on the **rising population.**

# **Concept: 5 Consequences of Hazards Can Be Minimized**

## Many times we deal with natural hazards in a ***reactive*** way.

## Following a disaster, we engage in

### Search and rescue

### Firefighting

### Providing food, shelter, and medical care

## This **does reduce** the loss of life and property

## **BUT: to move to a higher level of hazard reduction requires increased efforts to anticipate disasters and their effects.**

## Reactive Response: Impact of and Recover from Disasters

### The effect of a disaster upon a population may be either *direct* or *indirect*

#### Direct Effects:

##### People getting killed, injured, dislocated, or otherwise damaged

#### Indirect Effects:

##### Emotional distress, donation of money or goods, and the paying of taxes to pay for the recovery of property

### Direct effects are felt by fewer individuals, whereas indirect effects affect many more people

## **Stages of recovery** following a disaster are

### Emergency work

### Restoration of Services and Communication Lines

### Reconstruction

## **Life returns to normal basically**

## **Reconstruction II:**

### Planning is essential!!

### Don’t rush – evaluate how best to use recovery funds to rebuild to withstand future hazards

### **Rebuild to reduce damage and loss of life if another event should happen**

## **Anticipatory Response: Avoiding and Adjusting to Hazards**

### There is a **need to minimize the effects of disasters by evaluating the perception of the hazards**

### People need to be **educated to understand natural hazards** and **how they should deal with an event should they be involved in one**

## There are many ways which can be used to help reduce the consequences of natural hazards

### **Careful planning for land-use**

#### Don’t build on a flood plain

### **Insurance**

#### Have flood or earthquake insurance

### **Evacuation**

#### Have a plan if something happens

### **Disaster Preparedness**

#### Training and organization

### **Have an artificial control of Natural Processes**

#### Sometime they work, sometimes they don’t

### **Too often the option is to simply bear the loss**

# **Hazards Can Provide a Natural Service Function**

## Somewhat **ironic**:

### **Natural events which take human life and destroy property are often a benefit or natural service to nature**

#### **Periodic flooding** **supplies nutrients** to the land it floods.

#### **Forest fires** will release new seeds to for new growth

##### Uintah Forest, eaten by a deadly beetle, waiting to burn, will get rid of the beetle and the dead trees, and begin re-growth

#### **Landslides** will **dam up stream** and make a lake for **important water storage**

#### If the **dam breaks**, then the **land downstream is rejuvenated**

#### The **Hawaiian Islands** are **growing due to lava flow** from the volcano eruptions

# **Global Climate Change and Hazards**

## **Global and Regional Climate Change**

### **Could affect the incidence of hazardous natural events such as storms, landslides, drought, and fires**

## **What might this happen to cause these increases?**

### Sea level is rising and growing warmer

### Erosion is increasing

### Shift in precipitation and development in deserts and semiarid lands

### Warming of the northern latitudes could become more productive, leading to population shifts

#### Could cause more wars, social and political upheavals

### Increase in energy in the atmosphere causing more thunderstorms and hurricanes